Green Diamond Resource Company's Annual Report

To

National Marine Fisheries Service

For

Permit 1060 – Mod 1

Juvenile Salmonid Outmigrant Trapping Program

Ryan Creek

2012

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INTRODUCTION

In 2012, Green Diamond Resource Company (GDRCo) conducted its ninth year of outmigrant trapping monitoring in Ryan Creek, under a National Marine Fisheries Service (NMFS) Section 10 Permit (1060-Mod 1). This monitoring project has been conducted since 2004 and in 2007 became part of the Effectiveness Monitoring Program under an approved Aquatic Habitat Conservation Plan (AHCP; GDRCo, 2006). The purpose of the Effectiveness Monitoring Program is to track the success of the AHCP conservation program in relation to the biological goals and objectives and provide a basis for adaptive management.

Ryan Creek provides habitat for federally listed salmonids from the Southern Oregon/North Coastal California (SONCC) coho salmon evolutionarily significant unit (ESU), California Coastal Chinook salmon ESU, and Northern California steelhead distinct population segment (DPS). Juvenile outmigrant trapping was conducted to obtain an annual population estimate of outmigrating salmonid smolts for these species and coastal cutthroat trout. The objectives of juvenile outmigrant trapping in Ryan Creek are to establish baseline and long-term trend data on the abundance of juvenile salmonid populations and help identify factors affecting outmigrant abundance and timing.

Outmigrant trapping was conducted in Ryan Creek from April 17th through June 29th 2012. This document reports the findings for the 2012 season and makes select comparisons to past monitoring at this site.

METHODS

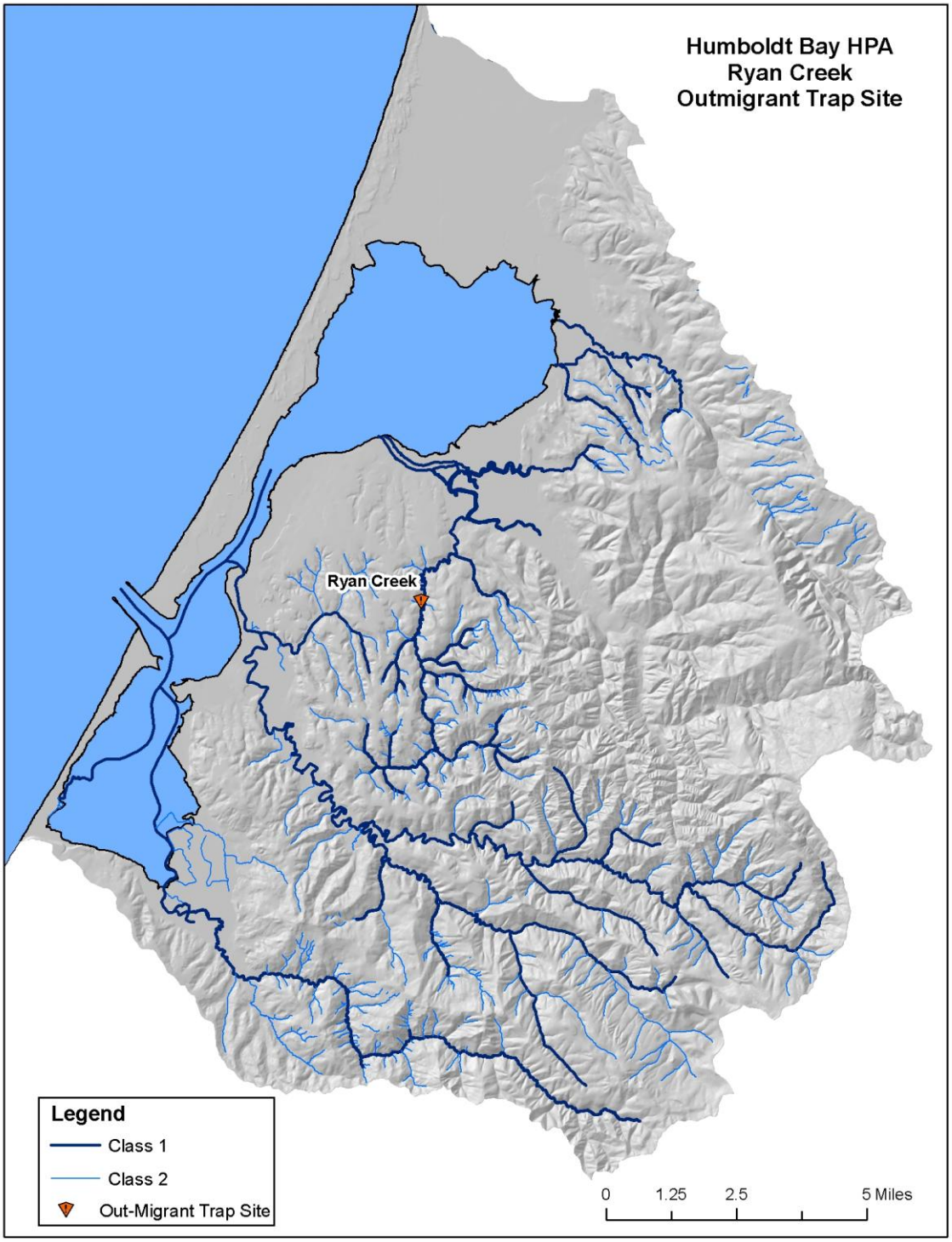
Study Site

Ryan Creek is a relatively small tributary (drainage area ≈12.8 mi^2) that drains into Humboldt Bay. The trap site is located ~2.17 miles upstream from the confluence of Ryan Creek with Ryan Slough. A map of the Humboldt Bay hydrolographic planning area (HPA) and location of the trapping site is provided in Figure 1. There is approximately 5.5 miles of suitable salmonid habitat above the trap site and approximately 1 mile below, at which point the creek is tidally influenced by Ryan Slough.

Outmigrant Trapping

Outmigrant trapping was conducted using a motor driven rotary screw trap (cone diameter = 1.5 meter). A DC motor is required to operate this trap because stream flows are insufficient to rotate the trap cone. Cylindrical mesh (opening size = 1/2 in.) enclosures were placed in the live box to provide cover for 0+ fish and limit in-trap predation. At times, low flows may require a check-dam to be constructed of T-posts and pallets to raise the water level enough to float the trap. The check dam is small (~ 2 feet high) with a 4 foot deep jump pool to allow for upstream migration of adult salmonids. Check dam installation was not necessary in 2012. The trap was operated 24 hours a day and checked each morning. In 2012, weir panels were installed on the upstream end of the trap to help guide fish into the opening of the cone and increase trap efficiency.

Figure 1. Map of the Humboldt Bay Hydrolographic Planning Area (HPA) and location of the Ryan Creek outmigrant trap site.



The data collection and handling procedures for captured fish varied depending on species and age class. Each day, all captured fish were identified, aged, and tallied. Due to the similarities between 0+ steelhead and 0+ cutthroat trout, proper identification is problematic (Baumsteiger et al., 2005 and Voight et al. 2008), therefore these species were categorized as "trout". All "trout" were 0+ fish. Steelhead and cutthroat trout in the 1+ or older age classes were distinguishable between species. Among 0+ captured, up to 20 fish/day of each species were measured (fork length, [FL], ± 1 mm) in addition, 1 day/week those same fish were weighed (± 0.1 gram). Adult cutthroat were defined as fish >200 mm with no signs of smoltification. All of these fish were measured, weighed, and then released approximately 0.5 mile (900 meters) downstream of the trap site. Among smolts, a sub-sample were marked and released upstream of the trap to estimate trapping efficiency (see below for details). These fish were marked individually and with a batch mark (i.e., seven-day rotating caudal fin clip), see below for details on marking methodologies. Scale sample(s) were also taken from each individually marked fish; once when marked and again if recaptured the following year (i.e., marked in 2011). Scale samples were collected from one of two locations on the body depending on capture sequence. Samples were taken from the left side during initial capture (i.e., marking) and from the right side during recapture. Scale samples were placed in individually labeled coin envelopes.

Marking

Fish were individually marked using passive integrated transponder (PIT) tags (Oregon RFID, Portland, Oregon). Passive integrated transponder tagging was performed in conjunction with a California Department of Fish and Wildlife (CDFW) study in the adjacent Freshwater Creek watershed. These shared data will be used to establish trends on factors leading to adult escapement, stray rates and other demographic information. Smolts (coho, steelhead and cutthroat $\geq$70mm FL) were fitted with a PIT tag (half-duplex, length = 12.0 mm) by way of a ventral incision posterior to the pectoral fin. Only smolts considered healthy (i.e., free of abrasions, undamaged tail, and normal coloration) were PIT tagged; those considered unfit were not tagged. Individual marks can be used along with caudal clips to determine the trap efficiencies, although this was not done in 2010. This practice was reinstated in 2011 and continued in 2012 to provide tissue samples for NMFS research in addition to providing an additional level of data quality assurance in the field.

Trap Efficiency

Trap efficiency was calculated for all species that were leaving the drainage on their seaward migration (i.e., smolts). Smolts were identified using distinct morphological characteristics including; fading parr marks, scale color transition towards silver, and darkening fin coloration. When possible, up to 20 smolts/species/day were marked for trap efficiency tests. However, in an effort to increase the overall percentage of marked coho, occasionally up to 30 coho smolts/day were PIT tagged when high numbers of coho smolts (e.g., $\geq$100) were captured on a single day.

Marked fish were allowed to recover in a perforated live-box that was located approximately 0.2 miles (300 meters) upstream of the trap site. The live-box has an automatic release device which was programmed to release fish 10 hours following capture. This release time allowed fish ample recovery time and provided cover (i.e.,

darkness) during their release to minimize predation. All recaptured fish were released downstream from the trap site to avoid pseudoreplication in calculations of capture probabilities.

Population Estimate

All outmigrant salmonid smolt population estimates were calculated using the Darroch Analysis with Rank Reduction (DARR 2.0.1 software) for analysis of stratified mark-recapture data (Bjorkstedt, 2005), where possible. In cases where the data did not meet the required DARR criteria, hard counts were used. Criteria violations could have resulted from low species captures or low and no recaptures for a species.

The relationship between population estimates and time were assessed for the cohort measured during this sampling year using linear regression. Data were analyzed using NCSS (Hintze 2007) and significance was assessed using and alpha of 0.05.

Growth Study

As part of the Ryan Creek population estimate, GDRCo is conducting a smolt overwinter growth study. During the fall, available habitat in Ryan Creek was electrofished for juvenile salmonids. Captured fish with a fork length greater than 70 mm were weighed, measured, and marked with PIT tags. The following spring, recapture and measurement of these outmigrant fish in the screw trap provide information on overwinter growth rates in Ryan Creek. Growth-study fish recaptured during the trapping season were precluded from the trap efficiency testing and released downstream.

Stream Temperature

Water temperature was monitored during the 2012 trapping season and these data were used to document the water temperatures trapped fish were exposed to during the latter portion of the trapping season. Water temperatures were measured using a HOBO® Water Temp Pro v^2 data logger (Onset Computer Corporation, Bourne, MA). The data logger was attached to the bottom of a t-post installed adjacent to the trap opening and recorded water temperature (ºC) on a 72 minute interval. Water temperature monitoring was not conducted in the early portion of the trapping periods because past monitoring efforts in Ryan Creek showed that water temperatures remain cold and stable during this time (unpublished data).

RESULTS

Trapping Effort

A summary of the 2012 trapping effort was compiled and compared to the history of outmigrant trapping at Ryan Creek (Table 1). In 2012, the trap was operational each day of the trapping season and the initiation of trapping was the latest to date. High flow in early spring prevented earlier installation of the screw trap.

Despite being operational every day of the trapping season, the trap partially fished on three days (4.2% of the season). Large wood debris lodged in the cone and electrical

problems (blown fuses) caused power interruptions and prevented the cone from spinning for a portion of these days. However, fish were trapped in the live box all three days indicating that the trap was operational for at least a portion of these three days.

Table 1. Summary of outmigrant trapping seasons conducted by GDRCo in Ryan Creek from 2004 - 2012.

	Year										
OMT parameter	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**	**Total**
Initiation date	16-Mar	23-Feb	5-Apr	15-Mar	12-Mar	10-Mar	26-Mar	8-Apr	17-Apr	21-Mar	-
Completion date	30-Jun	15-Jun	21-Jun	28-Jun	26-Jun	24-Jun	29-Jun	18-Jun	29-Jun	24-Jun	-
Season days	104	112	76	103	104	104	93	70	72	93	766
Operable days	100	101	74	100	103	100	83	63	72	88	796
Operable %	96%	90%	97%	97%	99%	96%	89%	90%	100%	95%	-
Inoperable days	4	11	2	3	1	4	10	7	0	5	42
Inoperable %	4%	10%	3%	3%	1%	4%	11%	10%	0%	5%	-

Trap Efficiency

Average trap efficiency (i.e., capture probability) for the 2012 trapping season was 68% (Range = 30 – 86%). The change in the 2012 trapping efficiency and it's comparison to past years can be found in Figure 2. Average trap efficiency in 2012 was higher than the mean average across all other years (56%). Efficiency was lowest during the first third of the season and improved to a consistent level (~ 80%) during the remainder of the season.

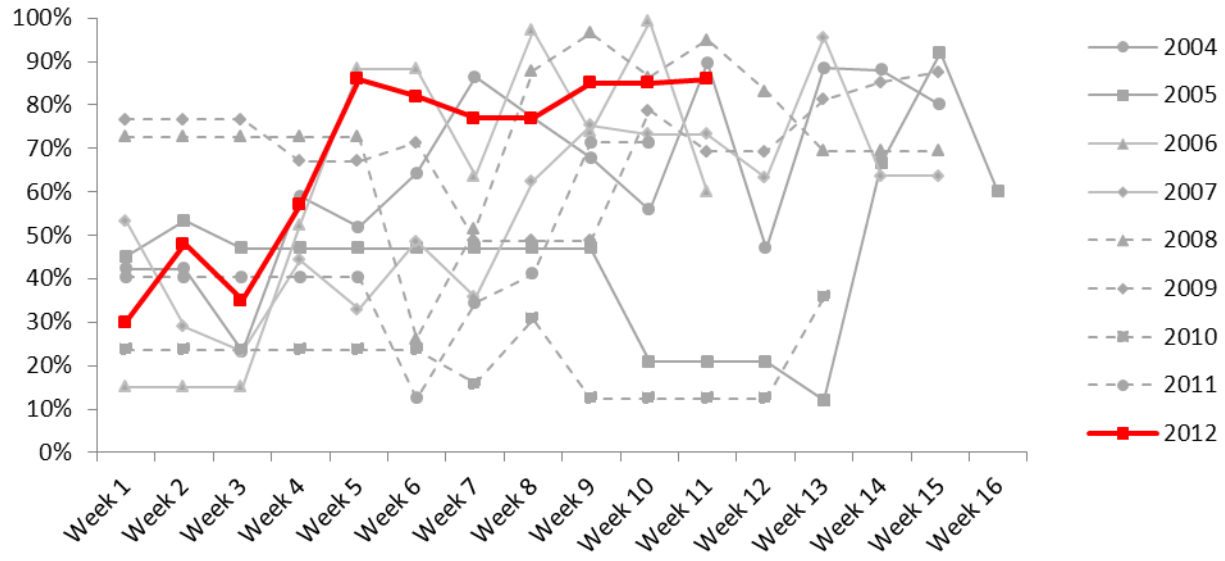


Figure 2. Summary of trap efficiency during 2004-2012 outmigrant trapping in Ryan Creek, Humboldt County, California.

Population Estimates

During the 2012 outmigrant trapping season a total of 2,548 salmonid smolts were captured. Fish captures (i.e., marked and unmarked fish) and recaptures were summarized for each species during this trapping period and compared to previous years (Table 2). Ten coho smolts recaptured in 2012 were not marked by GDRCo. These fish are included in the capture summary but were excluded from trap efficiency calculations. There was also one fish recaptured multiple times so pseudoreplication was prohibited when compiling summaries and calculating trap efficiency.

Population estimates and 95% confidence intervals for outmigrant smolt estimates were summarized for 2012 and combined with those from 2004-2011 to assess possible trends (Table 3 and Figure 3). The 2012 coho smolt estimate was larger than those calculated over the past four years in Ryan Creek. When compared to the other two cohorts (Figure 3A, green and red bars), this cohort of fish (Figure 3A, blue bars) appears to be one of the two strongest in the watershed. The average population estimate for this cohort is 4,750 (± 411) and when compared to the 2012 estimate, there was no clear difference from the average. Furthermore, no significant trend was found relating smolt estimate and year (linear regression: y = -389.8 (Year) + 787925.2, R-squared = 0.56) and the line was not significantly sloped (t-value = -1.15, p = 0.46). Smolt estimates for steelhead, and cutthroat trout remained very low, similar to the past few years. Note that for these two species, due to low capture or recapture numbers or other circumstances, it was not possible to generate population estimates for all years. In these cases, only hard counts are shown and are depicted without error bars.

While all historical data have been audited for accuracy and consistency for this report, GDRCo maintains and periodically updates a data quality routine that may detect previously unidentified errors. Estimates presented in this report that differ from previously reported figures should be considered the most accurate.

Table 2. Summary of smolt captures and recaptures during the outmigrant trapping season in Ryan Creek 2004-2012.

Year	Captured Smolts			Recaptured Smolts		
	Coho	Steelhead	Cutthroat	Coho	Steelhead	Cutthroat
2004	3,073	28	24	847	7	8
2005	1,453	10	9	318	2	0
2006	3,958	12	7	786	4	0
2007	2,669	9	4	893	0	2
2008	1,759	33	3	702	11	0
2009	2,214	8	0	740	3	0
2010	706	0	0	123	0	1
2011	379	1	2	103	0	1
2012	2,546	1	1	671	0	0

A total of 1,040 unmarked salmonids (i.e., excluding smolts) were captured in 2012 (Table 4). Coho YOY accounted for the majority (60%) of captures; followed by 1+ cutthroat (24%) and 1+ steelhead (12%).

Table 3. Smolt population estimates and confidence intervals (CI) from outmigrant trapping 2004-2012 in Ryan Creek, Humboldt County, California.

Year	Coho		Steelhead		Cutthroat	
	Smolt estimate	95% CI	Smolt estimate	95% CI	Smolt estimate	95% CI
2004	4,769	221	28*	-	88	58
2005	5,608	931	45	54	70	126
2006	6,509	714	33	24	7*	-
2007	5,223	377	9*	-	8	7
2008	2,514	200	93	41	3*	-
2009	3,571	204	21	18	0*	-
2010	3,334	702	0*	-	0*	-
2011	1,390	400	0*	-	4	5
2012	4,170	316	1*	-	1*	-

* indicates hard counts, estimate not calculated due to insufficient data

Table 4. Trapping totals for unmarked salmonids (i.e., non-smolts) in Ryan Creek, 2012.

Species	Age class	Number
Chinook salmon	YOY	0
Coho salmon	YOY	627
Cutthroat trout	1+	246
Cutthroat trout	Adult*	10
Steelhead	1+	123
Trout spp.	YOY	35

* fish were > 200 mm.

Mortalities

A total of six mortalities occurred during the 2012 outmigrant trapping in Ryan Creek (Table 5). Coho accounted for all of the mortalities, two (0+ fish) resulted from handling and the remainder were from unknown cause(s) since these fish were found dead in the trap box upon arrival to check the trap. One smolt mortality was a PIT tagged fish that was marked 14 days prior. Additional details on these mortalities are provided below and efforts to minimize them are described in the discussion.

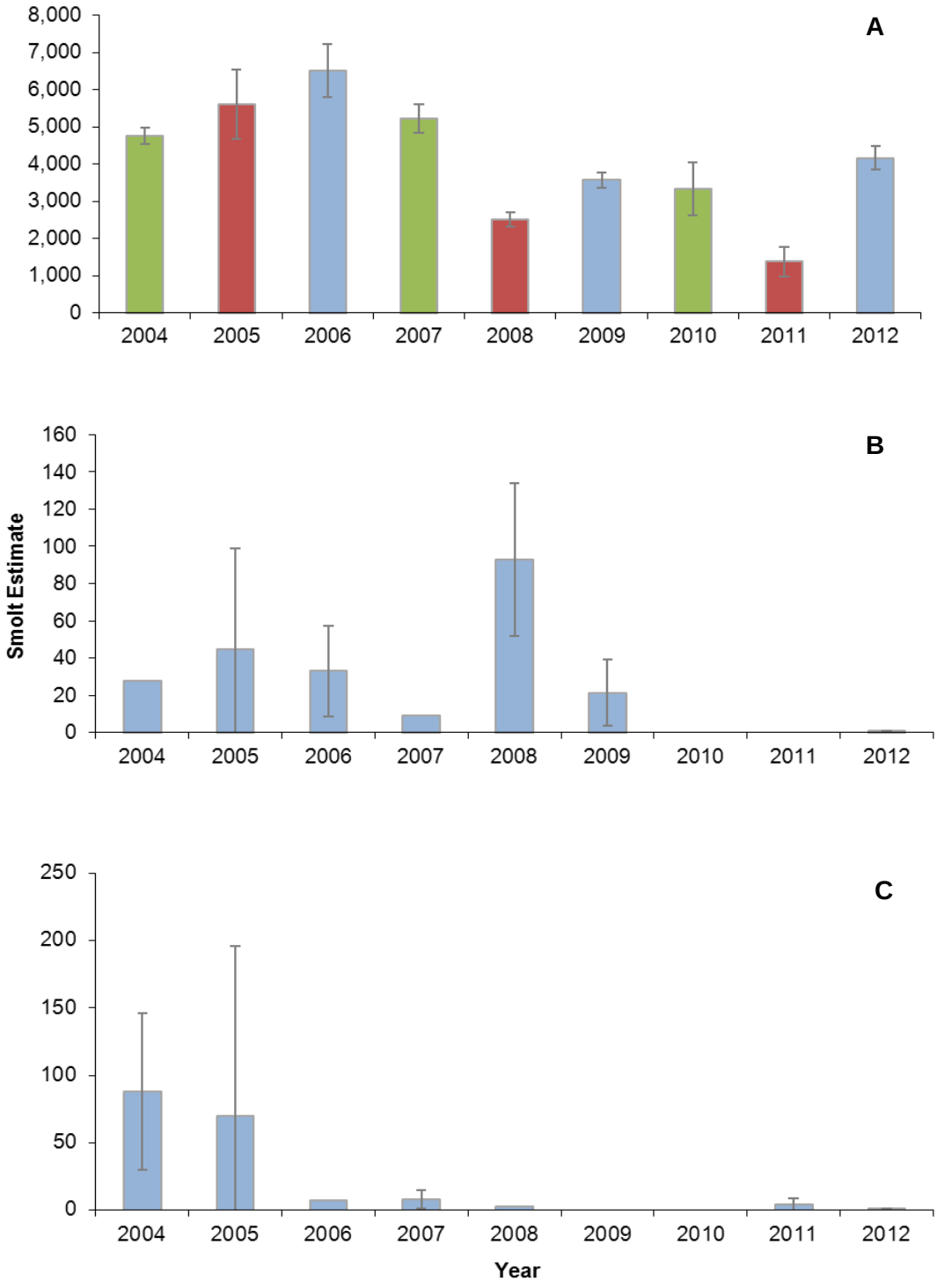


Figure 3. Outmigrant smolt estimates for coho salmon (A; colors represent three distinct cohorts), steelhead trout (B), and cutthroat trout (C) in Ryan Creek, 2004 - 2012.

Table 5. Summary of salmonid mortality during outmigrant trapping in Ryan Creek, 2012.

Species	Age class	Captured (#)	Mortality (#)	Mortality (%)
Coho salmon	Smolt	2,546	3	0.1
Coho salmon	0+	1,574	3	0.2
Cutthroat trout	Smolt	1	0	0.0
Cutthroat trout	1+	245	0	0.0
Cutthroat trout	Adult	10	0	0.0
Steelhead trout	Smolt	1	0	0.0
Steelhead trout	1+	123	0	0.0
Trout	0+	35	0	0.0
Total	-	4,535	6	0.1

Size and Condition

A total of 1,594 fish were measured and weighed during the 2012 outmigrant trapping season. Measurements collected during the trapping season were summarized for each species and age class (Table 6).

Based on field observations, the majority of fish handled appeared in good condition but comments (n = 17) about unfavorable conditions were noted. Among these comments, 13 were of injuries (e.g., bruised or scraped) and the remainder were suggestive of an infection or illness (e.g., bulging eyes).

Table 6. Summary of length and weight for salmonids captured (N = sample size) during the 2012 outmigrant trapping season in Ryan Creek, Humboldt County, California.

			Fork length (mm)		Weight (g)	
Species	Age Class	N	Range	Mean	Range	Mean
Coho salmon	Smolts	1,013	72 - 156	103	3.9 - 37.5	11.7
Coho salmon	YOY	183	34 - 68	40	0.2 - 2.9	0.6
Cutthroat trout	Smolts	1	-	161	-	42.0
Cutthroat trout	1+	242	52 - 195	128	4.6 - 78.4	24.5
Cutthroat trout	Adults	10	208 - 240	224	96.3 - 152.2	120.0
Steelhead trout	Smolts	1	-	185	-	62.0
Steelhead trout	1+	121	62 - 182	109	2.8 - 66.5	17.8
Trout spp.	YOY	23	25 - 89	55	0.1 - 4.1	2.4

Growth Study

Among the 0+ coho captured (N = 232) in 2011, 59 (25.4%) were recaptured during the 2012 trapping season and used to calculate growth rates. The overwinter growth rates calculated for coho salmon after the 2012 water year were summarized and combined with all other years (Table 7). The changes in overwinter growth for this water year were smaller but similar to those from past years.

Table 7. Summary of 2004 - 2012 overwinter growth rates for coho salmon in Ryan Creek, Humboldt County, California..

Water year	Sample size	Δ Length (mm)	Δ Weight (g)	Δ Weight (%)	Days Between Captures	Growth rate length (mm/day)	Growth rate weight (g/day)
2006	46	42.5	12.9	270.5	221.1	0.19	0.06
2007*	0	-	-	-	-	-	-
2008	72	22.1	6.4	90.6	190.6	0.12	0.03
2009	70	28.0	8.1	138.8	198.0	0.14	0.04
2010	17	35.5	11.7	192.3	225.1	0.16	0.05
2011	17	27.4	8.3	129.5	235.9	0.12	0.04
2012	56	23.5	5.7	109.3	204.8	0.11	0.03

* No fish were marked in fall 2006.

A total of 205 coho (0+), 6 steelhead (1+), and 4 cutthroat (1+) were captured by electrofishing, measured, weighed, PIT tagged, and released in September and October 2012. No mortality occurred during electrofishing or marking. Recapture of these fish in the 2013 outmigrant traps will provide information on overwinter growth rates for 2012, and will be presented in next year's summary report.

Migration timing

Migrating smolts were captured from the first trapping day (April 17th) and continued through June 28th but coho smolts generally finished emigrating by the first week of June. A frequency histogram of daily smolt captures (i.e., not estimates) shows the timing of coho smolt migration in Ryan Creek (Figure 4). The majority (63 %) of coho smolts emigrated from Ryan Creek during the month of May and migration peaked on May 16th (n = 146 smolts). However, an early peak was also apparent at the end of April, with a similar peak of outmigrants on April 25th (n = 144).

Species Composition

Eight species (7 fish and 1 amphibian) were captured in the screw trap during the 2012 outmigrant trapping season in Ryan Creek (Table 8). Forty-three percent of the fish species were in the genus *Oncorhynchus*. The remainder of species were incidental captures of non-target species. Species composition in 2012 was consistent with that recorded in years past.

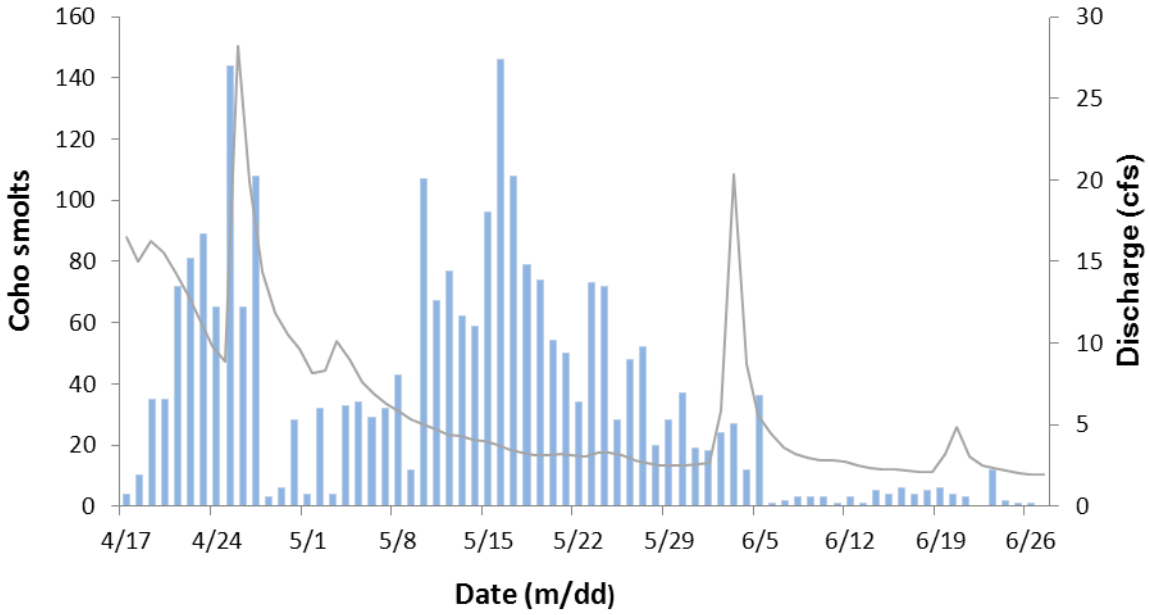


Figure 4. Coho outmigrant timing (blue bars) and stream discharge (gray line) during the 2012 trapping season in Ryan Creek, Humboldt County, California.

Table 8. Species captured during outmigrant trapping in Ryan Creek, 2004-2012.

		Year								
Common Name	**Scientific Name**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Coho Salmon	*Oncorhynchus kisutch*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Chinook Salmon	*Oncorhynchus tshawytscha*	N	Y	N	N	N	N	N	N	N
Steelhead Trout	*Oncorhynchus mykiss*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Coastal Cutthroat Trout	*Oncorhynchus clarki clarki*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pacific Lamprey	*Lampetra tridentata*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Western Brook Lamprey	*Lampetra richardsoni*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Prickly Sculpin	*Cottus asper*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Three-Spined Stickleback	*Gasterosteus aculeatus*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pacific Giant Salamander	*Dicamptodon tenebrosus*	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tailed Frog	*Ascaphus truei*	N	N	N	N	N	N	N	N	N

Stream Temperature

Water temperature was monitored for 39 days (May 19 – June 28; 54% of the trapping period) during the 2012 trapping season. A total of 820 measurements were collected during this time. Mean daily water temperatures were calculated from these data and a temperature profile was created (Figure 5). Throughout the trapping season water temperatures increased as expected but temperatures stayed within the thermal tolerances for captured species.

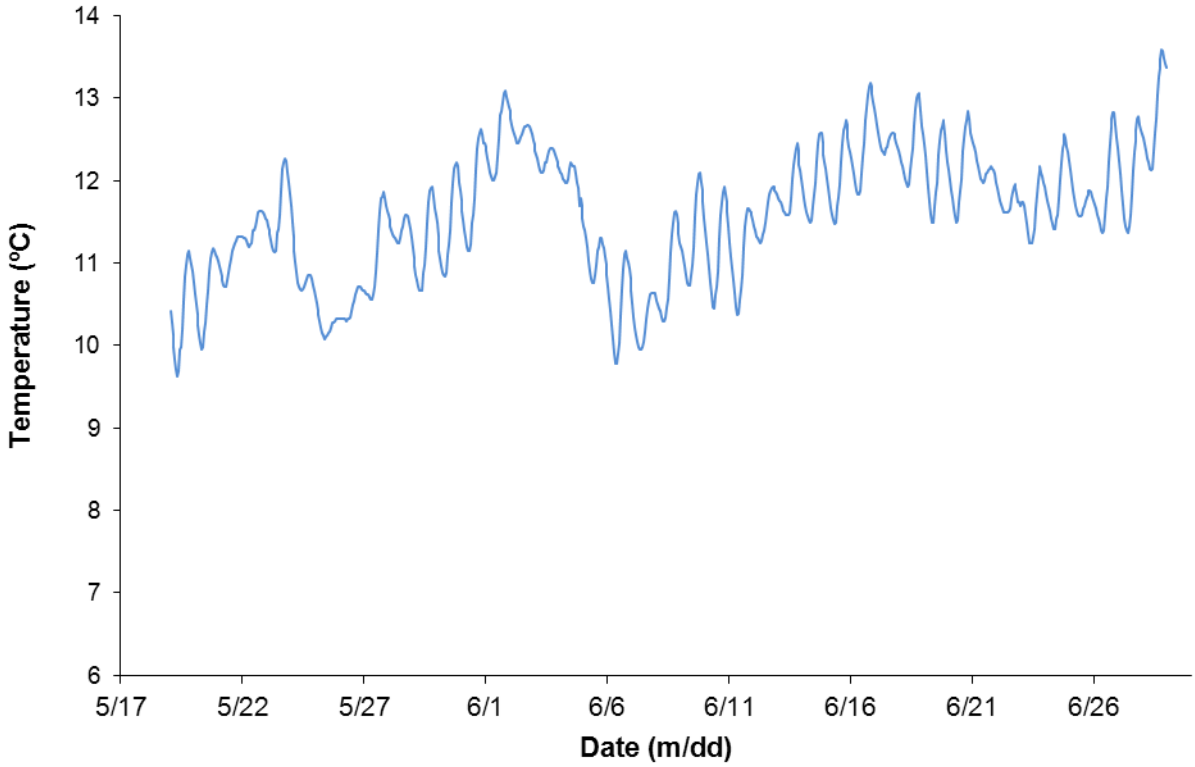


Figure 5. Mean daily water temperature recorded in Ryan Creek during the 2012 trapping period.

DISCUSSION

Population Estimates and Trap Efficiency

Based on the three year life history of coho salmon (Murphy and Meehan, 1991), the 2012 smolt estimate for coho in Ryan Creek was the third time this cohort was measured; allowing for limited assessment of the population trend. Despite an apparent decrease in smolt production since 2006, the observed changes are insignificant and this cohort has been producing fairly consistent and average smolt numbers. The observed dynamics in smolt estimates in Ryan Creek are likely the result of multiple factors, including climate, ocean conditions, predator-prey dynamics, spawning and rearing habitat availability, and

anthropogenic disturbances, acting synergistically. Further monitoring will help better assess and understand the population trend and dynamics for this and the other cohorts.

There have been consistently low population estimates for steelhead and cutthroat over the past few years and understanding these results may be confounded for several reasons. First, low sample sizes produced low confidence in population estimates which limits assessing population trends. Second, both species are iteroparous and have variable fresh water rearing times (steelhead = 1-3 years and cutthroat = 2-5 years) and ocean rearing times (steelhead = 1-4 years and cutthroat = 1-2 years) (Moyle, 2002), making it difficult to assess population trends using juvenile estimates alone. Due to these complications, the smolt estimates calculated from this monitoring effort should be used judiciously.

In years past, high flows have apparently influenced smolt captures, however, flow did not appear to have influenced smolt captures in 2012. Unlike many trapping seasons, flows were consistently low with only two small storm events. The rain event in late April did correspond with a short delay in smolt emigration but did not seem to effect the function of the screw trap.

There is little concern that the relatively late start of the trapping season in 2012 had a considerable effect on the coho smolt estimate in Ryan Creek. Outmigrant trapping was also conducted in 2012 at Prairie Creek. This site was trapped from late February through July and approximately 6% of the coho smolts emigrated by April (M. Sparkman, pers. comm.). Given this finding and assuming similar phenology in coho smolt emigration between sites, the 2012 trapping efforts in Ryan Creek was likely sufficient to estimate approximately 94% of the actual number of coho smolts.

Only one duplicate recaptures occurred in 2012 which indicates the release location was largely effective. The PIT tag data prior to 2007 showed that several smolts released downstream after first recapture, moved back upstream and were subsequently captured again (GDRCo, 2007) thus creating a potential problem regarding the numbers derived for population estimates. Miller and Sadro (2003) experienced a similar problem using a screw trap and tried unsuccessfully to compensate statistically for these in the estimate. To address this problem in Ryan Creek, the release site was moved in 2007, from 300 feet to one half mile below the trap site. The increased distance between the trap site and release site has reduced the number or eliminated multiple recaptures since 2006.

A mechanized rotary screw trap is an excellent tool for collecting information pertaining to salmonid production in the Ryan Creek drainage. The screw trap system efficiently trapped this stream during low and normal flows. Improvements will continue to be made to increase trap efficiency.

Size and Condition

The sizes and weights documented for salmonids in Ryan Creek during the 2012 outmigrant trapping season were similar to those reported in years past. The lack of any obvious change in fish size and condition suggests that there have been no significant changes to the available rearing habitat in Ryan Creek. Salmonid growth increases at varying rates depending on the abundance of aquatic insects and plant life during critical rearing periods (Murphy and Meehan 1991). Size can also be influenced by density

related competition (Imre et al. 2005). The seemingly consistent size and length among salmonids in Ryan Creek suggests that these factors are relatively constant in the Ryan Creek watershed.

Mortalities

Several factors may have contributed to the mortalities observed related to the trapping and handling process during the 2012 outmigrant trapping in Ryan Creek, however, the specific reason(s) for any of these mortalities is unclear. Some of the most likely reasons for fish mortality while operating the outmigrant traps may include improper handling, injury while marking, trapping injury, debris loading in the trap box, predation, and employee inexperience. Below we considered the potential role of each of these factors in the observed mortality in 2012.

A couple mortalities resulted from handling injury and one possibly from marking. Those resulting from handling were specifically from netting YOY fish out of the trap box when large numbers of fish had been captured. While netting high densities of fish out of the trap box, it is difficult to avoid accidentally pinching a YOY fish against the box with the hoop of the net. Efforts will continue to be made into the future to eliminate all mortalities resulting from handling procedures. The specific reason for the mortality of the marked coho is unclear. This fish appeared healthy when marked and when found dead, 14 days following being marked, it did not have any noticeable signs of infection around the PIT tag incision site. These facts suggest that its death was not likely a direct effect of being PIT tagged or the handling procedure. The most likely cause of death for this fish was disease or illness. Upon recapture it had a tattered tail, looked emaciated, and had a bulging eye. It is still unclear if these symptoms are attributed to any particular disease but these and other symptoms will continue to be documented by the field crew and the frequency of symptoms will be monitored.

It unlikely that employee training and experience negatively contributed to the observed mortality in 2012. In fact, the low mortality may be partly attributable to the focused effort of our experienced field crew. All crew members involved in conducting outmigrant trapping in Ryan Creek received sufficient training and all staff have multiple years of direct experience using the trapping equipment and following the field protocols. This factor is easiest to control for with proper training and supervision of field crews in fish handling techniques, and the company's emphasis on the importance of this issue.

The continued absence of YOY trout mortalities in 2012 was an improvement over years past and may have been attributed to limited high flow events and efforts to minimize debris loading in the trap box. Mortality usually associated with heavy debris loading in the trap-box at Ryan Creek typically occurs during periods of high winds and high flows (GDRCo, 2010). Young-of-year fish are especially susceptible to this source of mortality. In 2012, during periods of heavy rain or wind, the traps were checked a second time in the later afternoons to clear accumulated debris from the live-box in an attempt to minimize mortalities associated with debris loading. This precautionary action appears to be effective and will continue.

Predation in the trap box is difficult to prevent and the most likely source of the unexplained mortality in 2012. During the trapping season, one tactic was used to minimize predation. A small screen cylinder was placed in the trap box to create a refuge

so that smaller fish can enter and seek shelter from larger fish which are excluded. This effort may have helped keep the unexplained mortalities low.

While the mortalities observed in 2012 were again very low, both in percent of fish handled and relative to the take limits provided in our Section 10a permit, GDRCo continues to make efforts to further reduce mortality associated with the monitoring efforts. For example, the trapping equipment will be inspected for potential fish hazards and repaired as needed prior to deployment in 2013. Furthermore, we will continue to develop and implement new improvements in the trap operation and handling procedures as part of our ongoing efforts.

Migration Timing

The migration timing observed in Ryan Creek was consistent with that observed at Ryan Creek in past years. Factors that tend to affect the timing of migration include the size of the fish, flow conditions, water temperature, dissolved oxygen levels, day length, and availability of food (Shapovalov and Taft 1954). These factors presumably contributed to the outmigrant phenology observed in 2012 at Ryan Creek.

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